



STATE COLLEGE OF WASHINGTON  
AGRICULTURAL EXPERIMENT STATION  
Pullman, Washington

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Division of Dairy Husbandry  
and  
Western Washington Experiment Station

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## Raising Dairy Calves With Dried Skimmilk

by  
J. C. Knott, R. E. Hodgson, and E. V. Ellington

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Bulletin No. 273  
July, 1932

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<sup>2</sup>In cooperation with the United States Department of Agriculture.

<sup>3</sup>On leave.

## RAISING DAIRY CALVES WITH DRIED SKIMMILK

By J. C. Knott, R. E. Hodgson and E. V. Ellington

### Introduction

With the development of all parts of the country, and increase in population, the demand for milk and milk products has been greatly increased. Where cream or butter is sold from the farm, the problem of raising calves is simple because sufficient skimmilk is available. Marketing whole milk from the farm has become a common practice in many of the dairy sections. On those farms where whole milk is marketed and skimmilk is not available, calf raising becomes a serious problem and many dairymen dispose of their calves at birth rather than stand the loss of income due to feeding the calves whole or skimmilk. Feeding whole milk to dairy calves during the first few months of their lives greatly increases the cost and many dairymen who are selling whole milk prefer to buy replacement cows rather than raise them. In addition to the loss of income sustained by dairymen who separate part of their milk to furnish skimmilk for the calves, there is a great deal of extra work which is not welcome.

Experience has shown that it is almost impossible to decidedly improve the quality of our dairy herds where these are maintained by buying replacements. Another serious factor which confronts the dairyman who maintains his herd in such a manner is the possible introduction of disease.

Raising the best heifer calves in the herd when good sires are used is the surest method of herd improvement.

### Other Investigations

The search for a substitute for skimmilk in calf raising has been carried on extensively over a period of years with varying success.

Many by-products of the dairy industry have been used successfully in raising dairy calves. At the Washington Station (1) experiments have been conducted with whole milk, separated skimmilk, buttermilk, semi-solid buttermilk, dried buttermilk, dried skimmilk and both home-made and commercial calf meals.

The best and most economical gains were made with skimmilk fed fresh and warm from the separator. Re-made dried skimmilk and re-made dried buttermilk gave better results than the semi-solid buttermilk or the calf meals. One pound of the dry material was added to

nine pounds of water to make the re-made skimmilk or buttermilk. With this material, calves were raised and consistently made greater gains than indicated by Eckles' (2) normal growth standards for dairy heifers.

Lindsey and Archibald (3) conducted experiments in which they fed calves liquid skimmilk, skimmilk powder, buttermilk, buttermilk powder, and diluted whole milk. The best results considering economy and growth were obtained when raising calves on skimmilk powder in limited amounts. Calves raised according to this method of feeding received powdered skimmilk in solutions to the end of the fourth month.

Mixing the skimmilk powder with the water, keeping the pails clean, etc., consumed considerable time and with this in mind a number of experiments have been conducted to determine the feasibility of feeding the powdered skimmilk in the grain mixture.

Jones, Brandt, and Wilson (4) in reporting experimental results state: "Where liquid skimmilk is not available calves can be raised on a ration of dry calf meal, hay and water and be normal in size at 180 days of age."

Williams and Bechdel (5) have compared growth and thriftiness of calves raised on skimmilk ration with calves raised on the blood flour ration developed by the New Jersey Agricultural Experiment Station (6). Their ration consisted of 25 parts of skimmilk powder, 20 parts yellow corn, 27 parts ground oats, 16 parts linseed meal and 10 parts wheat bran. Whole milk was fed up to six weeks of age. They reported that calves raised on this ration plus legume hays were 94.1 per cent normal in height at withers and 80 per cent normal in weight at six months of age.

Experiments were conducted at the Trumbull County Experiment Farm (7) with groups of calves fed fresh whole milk, fresh separated milk, powdered skimmilk remixed with water and powdered skimmilk fed dry after two months of age. When both feed and labor were considered feeding dry milk-grain mixture was the most economical way to feed calves. Calves fed in this way made an average daily gain of 1.5 pounds as compared with 1.6 pounds for the group receiving whole milk.

#### Objects of the Experiment

In 1928, the Dairy Department of the State College did some preliminary work using powdered buttermilk in raising dairy calves. The calves were fed whole milk for three weeks and were then changed to re-made dried buttermilk (one pound of dried buttermilk to nine pounds of water). At six weeks of age, dried buttermilk was added to the grain mixture and at eight weeks of age the re-made buttermilk was

discontinued. The calves made a satisfactory growth and compared very favorably with calves continued on the re-made buttermilk.

In 1930, through the cooperation of the American Dry Milk Institute, investigational work with dry skimmilk for feeding dairy calves was started.

This experiment was conducted to determine, first, if dairy calves could be raised on hay, water and a dry calf meal containing dried skimmilk when no other milk was fed after six weeks of age; second, if calves so raised would make normal growth, and third, if calves could be economically raised in this manner.

#### Experimental Procedure

**Animals Used:** The calves used in this experiment were pure breds dropped in the herds of the State College of Washington at Pullman and the Western Washington Experiment Station at Puyallup. Thirty-one female calves were included of which 23 were Holsteins, four were Guernseys, two were Jerseys, and two were Ayrshires. In addition to these heifer calves, eight bull calves were started on the experiment. Since all but two of the bull calves were disposed of before they were six months of age, only the data on the female calves are included in the results given in this publication.

The investigation was conducted over a period of one and one-half years, the calves being placed on the experiment as they were dropped.

**Feeds Used:** The calves had access at all times to clean water and good alfalfa hay in unlimited quantities. The grain mixture used is shown under mixture No. 1 in Table 1.

Since the blood meal was quite high in price, this mixture was later changed by reducing the amount of blood meal by 50 pounds and increasing the wheat bran a like amount. This latter mixture is the one given as mixture No. II and was made up as shown in Table 1.

The dried skimmilk used in this experiment was furnished by the American Dry Milk Institute and was produced by the Whatcom County Dairymen's Association. This material was produced by the spray process. The barley and oats were grown locally and were ground with a hammer mill. The bran was made from eastern Washington wheat. The blood meal was not of very good quality. The alfalfa hay was of good quality as most of it would grade as U. S. No. 1.

**Method of Feeding and Management:** The calves were weighed and the height at the withers measured as soon after birth as possible. Each calf was left with its mother for about 48 hours after which it was put in an individual pen. Whole milk of a low butterfat content was fed until the calf was two weeks of age at which time it was gradually changed to re-made skimmilk. About a week was needed to make this change. The re-made skimmilk was made by mixing one pound

of the dried skimmilk in nine pounds of water and was warmed to 98° F. Both the whole milk and the re-made skimmilk were fed at the rate of one pound daily for each ten pounds of live weight. At five weeks of age, the re-made skimmilk was gradually discontinued so

**Table 1. Composition of Experimental Grain Mixtures**

Ingredients	Mixture No. I	Mixture No. II
Dried skimmilk (pounds) .....	250	250
Ground barley (pounds) .....	200	200
Ground oats (pounds) .....	200	200
Wheat bran (pounds) .....	150	200
Blood meal (pounds) .....	100	70
Linseed meal (old process) (pounds) .....	70	50
Sterilized bone flour (pounds) .....	20	20
Salt (pounds) .....	10	10
Digestible crude protein (per cent) .....	23.41	21.36
Total digestible nutrients (per cent) .....	73.23	72.59

that at six weeks of age the calf was receiving no liquid milk. After the calves were about two weeks old, alfalfa hay and clean water were kept before them at all times. When the calves were about one week of age, the grain mixture containing the dried skimmilk was placed before them. Every effort was made to get them to eat the grain mixture as soon as possible. At four weeks of age, most of the calves were eating considerable hay and from one to two pounds of grain daily. The first calves were allowed unlimited amounts of the grain feed to find out how much they would consume without harm. It was found that at the age of from three to six months they could consume five pounds of this mixture without any apparent ill effects. Over this amount, however, digestive disturbances occurred.

The calves were weighed and the height at the withers measured weekly. Feed consumption records were kept on individual calves by weighing each day the amounts of feed offered. Feed not consumed daily was allowed to remain and amounts added were reduced so that all was consumed.

### Experimental Results

**Growth:** The growth rate of the experimental animals is shown in Table 2. The results with Ayrshires, Jerseys and Guernseys used in this experiment are included in this table, but due to the small numbers, little significance can be attached to them. With the exception of heifer No. 3018, however, all of the animals of these breeds made

Table 2. Growth Rate of Experimental Animals

Calf No.	Breed	Birth weight lbs.	Weight at 6 months lbs.	Av. daily gain lbs.	Per cent normal gain	Birth height inches	Height at 6 months inches	Av. daily gain inches	Per cent of normal gain
<b>Ration 1</b>									
1043	A	76	297	1.22	100.0	27.7	35.8	.04	76.3
1044	A	62	260	1.09	91.7	25.2	36.2	.06	101.7
Average		69	278.5	1.16	95.35	26.5	36.0	.05	89.0
<b>Ration 2</b>									
3016	G	85	310	1.24	.....	29.5	39.0	.05	.....
3017	G	75	292	1.20	.....	27.1	37.8	.05	.....
Average		80	301	1.22	.....	28.3	38.4	.05	.....
<b>Ration 3</b>									
110	H	88	391	1.68	118.39	27.3	40.3	.07	114.3
111	H	78	302	1.22	85.92	27.5	37.4	.06	103.2
112	H	90	322	1.28	90.14	29.5	39.3	.05	83.7
113	H	88	403	1.70	119.72	29.1	41.3	.07	104.8
114	H	91	358	1.47	103.52	29.5	40.2	.06	85.2
162	H	95	365	1.48	104.22	31.0	41.0	.05	87.5
163	H	96	374	1.53	107.75	30.0	41.8	.06	100.0
164	H	72	301	1.25	88.03	26.9	38.3	.06	100.0
165	H	105	365	1.43	100.70	30.0	39.9	.05	87.5
166	H	103	375	1.49	104.93	30.1	40.6	.06	93.8
167	H	79	320	1.32	92.96	27.8	39.1	.06	100.0
168	H	89.54	352.36	1.44	101.41	28.96	40.58	.064	101.2
Average									
2077	J	48	282	1.27	112.39	25.2	37.0	.06	106.7
2078	J	47	259	1.16	102.65	24.4	36.6	.07	116.7
Average		47.5	270.5	1.22	107.52	24.80	36.81	.07	111.7

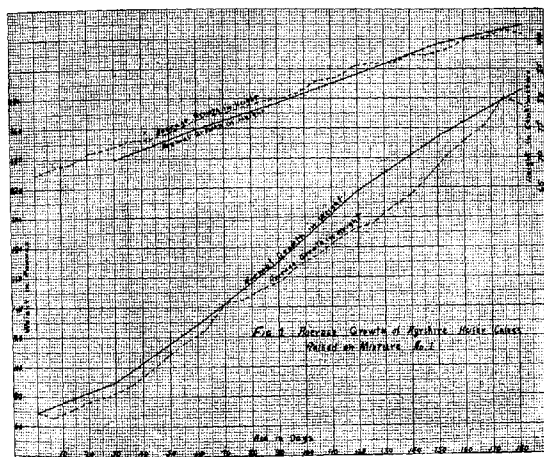


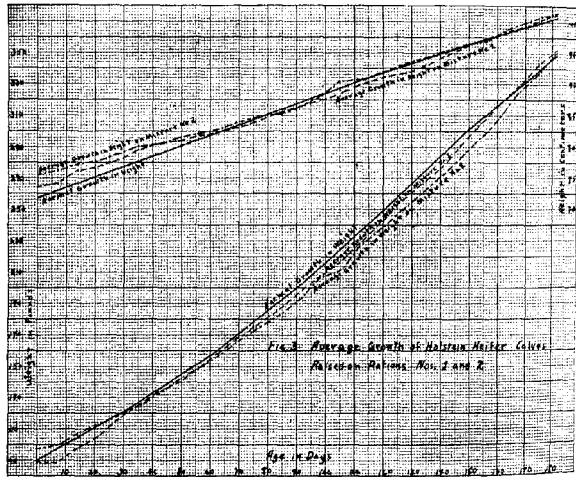
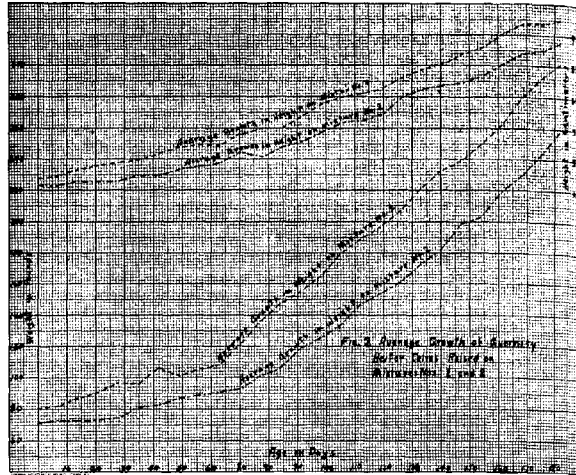
Table 2. Growth Rate of Experimental Animals (Continued)

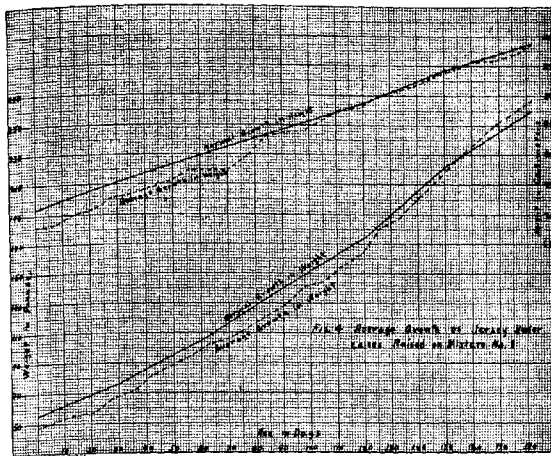
Calf No.	Breed	Birth weight lbs.	Weight at 6 months lbs.	Average daily gain lbs.	Per cent normal gain	Birth height inches	Height at 6 months inches	Average daily gain inches	Per cent of normal gain
<b>Ration 2</b>									
3018	G	50	205	.85	.....	26.3	35.0	.04	.....
3019	G	92	316	1.23	.....	29.5	39.4	.05	.....
Average		71	260.5	1.04	.....	28.5	37.2	.05	.....
116	H	103	330	1.25	88.03	31.1	40.9	.05	85.6
117	H	121	344	1.23	86.62	31.1	40.8	.05	84.4
118	H	100	366	1.45	102.11	30.7	40.2	.05	82.5
119	H	115	336	1.19	83.80	29.9	38.2	.04	70.0
120	H	88	360	1.49	104.93	28.7	39.7	.06	95.0
121	H	106	362	1.41	99.30	29.9	41.0	.06	93.9
169	H	88	348	1.43	100.70	28.9	39.9	.06	93.8
170	H	88	349	1.43	100.70	29.3	40.5	.06	100.0
171	H	90	379	1.59	111.97	29.2	40.4	.06	100.0
172	H	92	347	1.40	98.59	29.4	39.9	.06	93.8
173	H	86	310	1.23	86.62	28.8	39.0	.05	87.5
174	H	98	384	1.57	110.56	29.8	41.7	.07	106.3
Average		97.92	351.25	1.39	97.89	29.71	40.18	.057	91.3
Average of all Holsteins									
		93.91	351.78	1.42	100.0	29.3	40.37	.061	96.85

very satisfactory growth. In comparison with Eckles' (2) normal growth tables the Holstein heifers were above normal in weight at six months of age.

The average weight of the Holstein calves on ration I was .46 pounds under normal at birth, while the final weight at six months of age averaged 1.11 pounds above normal. The average weight of Holstein calves on ration II was 7.29 pounds heavier than normal at birth and 2.25 pounds above normal at six months of age. Calves on ration I showed a slightly greater rate of gain in weight. The average rate of gain in height at withers was also a little greater for the calves on ration I. The average weight and height of all Holstein calves at six months of age was slightly above normal. The average daily gain in weight for the six-month period was 1.42 pounds which is approximately normal. The average daily gain in height was 96.85 per cent of normal. It will be noticed in Figures 1 to 4 inclusive, which show the height and weight curves as compared to normal, that generally there was a slightly decreased rate of growth which began at about 2½ months of age and continued until approximately 5 months of age, indicating that there was a period of what might be called retarded growth. It seems evident, however, that by the 180th day these calves were gaining at a greater rate than normal.







**Feed Consumption and Feed Cost:** The price per pound of the materials included in the rations are shown in Table 3. The feed consumption and feed cost of the experimental calves are shown in Table 4. The Holsteins on ration II ate more hay but less of all other feeds than those on ration I. The average feed cost for the six months was \$1.02 less for the Holsteins on ration II. The average feed cost for all Holsteins was \$20.02.

The feed consumption and feed cost per unit of growth is shown in Table 5. The Holsteins on ration II consumed more alfalfa hay per unit of growth than those fed ration I, but less of each of the other feeds. The feed cost per unit of gain was the same for both rations.

**Table 3. Cost of Feeds Used**

Feedstuffs	Price per pound
Dried skim milk .....	5.00 cents
Ground barley .....	1.00 "
Ground oats .....	1.00 "
Wheat bran .....	0.80 "
Blood meal .....	4.00 "
Linseed meal (old process) .....	2.25 "
Sterilized bone flour .....	3.50 "
Salt .....	1.25 "
Mixture No. 1 .....	2.41 "
Mixture No. 2 .....	2.25 "
Whole milk .....	1.50 "
Alfalfa hay .....	0.75 "

Table 4. Feed Consumption and Feed Cost of Experimental Calves

Calf No.	Breed	Whole milk		Re-made skim milk		Grain mixture		Alfalfa hay		Total feed cost
		Total	Av. daily*	Total	Av. daily**	Total	Av. daily	Total	Av. daily	
		Lbs.		Lbs.		Lbs.		Lbs.		
<b>Ration 1</b>										
1043.....	A	112.5	7.50	166.0	7.90	680.1	3.76	233.3	1.29	\$20.67
1044.....	A	99.9	6.66	234.0	11.14	437.8	2.40	452.4	2.49	16.61
Average.....	A	106.2	7.08	200.0	9.52	559.95	3.10	342.85	1.90	18.64
3016.....	G	110.7	7.38	204.0	9.71	445.7	2.46	495.7	2.74	17.16
3017.....	G	86.5	5.77	160.5	7.64	469.9	2.60	535.2	2.96	17.43
Average.....	G	98.6	6.58	182.25	8.68	457.8	2.55	515.45	2.85	17.30
110.....	H	92.1	6.14	215.0	10.24	727.7	4.04	282.7	1.58	22.11
111.....	H	126.0	8.40	228.1	10.86	572.9	3.13	182.2	1.00	18.21
112.....	H	183.0	12.20	245.3	11.68	635.4	3.51	263.6	1.46	21.20
113.....	H	137.0	9.13	203.9	9.71	707.5	3.82	544.9	2.94	24.22
114.....	H	134.0	10.27	208.3	9.92	519.3	2.85	680.2	3.74	20.97
162.....	H	144.0	9.60	239.5	11.40	489.0	2.69	623.4	3.42	19.96
163.....	H	166.0	11.06	247.0	11.76	531.9	2.92	774.2	4.25	22.40
164.....	H	110.5	7.37	201.0	9.57	448.6	2.46	490.4	2.69	17.16
166.....	H	158.5	10.57	266.0	12.67	441.8	2.43	555.3	3.05	18.52
167.....	H	174.0	11.60	300.0	14.29	523.6	2.88	655.9	3.60	21.65
168.....	H	135.5	9.03	241.0	11.48	483.0	2.66	618.5	3.40	19.35
Average.....	H	143.61	9.58	235.92	11.23	552.97	3.03	515.57	2.83	20.55
2077.....	J	124.8	8.32	198.0	9.43	486.1	2.64	515.3	2.80	18.43
2078.....	J	114.8	7.65	241.6	11.50	448.7	2.44	440.7	2.40	17.09
Average.....	J	119.8	7.98	219.80	10.22	467.4	2.54	478.0	2.60	17.74

Table 4. Feed Consumption and Feed Cost of Experimental Calves (Continued)

Calf No.	Breed	Whole milk		Re-made skim milk		Grain mixture		Alfalfa hay		Total feed cost
		Total	Avg. daily*	Total	Avg. daily**	Total	Avg. daily	Total	Avg. daily	
		Lbs.		Lbs.		Lbs.		Lbs.		
<b>Ration 2</b>										
3018.....	G	81.8	5.45	85.0	4.05	349.0	1.91	336.9	1.84	\$12.59
3019.....	G	84.5	5.63	58.3	2.78	498.4	2.74	553.1	3.04	17.22
Average.....	G	83.15	5.54	71.65	3.42	423.70	2.30	445.0	2.40	15.18
116.....	H	107.0	7.13	151.0	7.19	515.3	2.85	736.4	4.07	20.29
117.....	H	121.0	8.07	131.0	6.24	515.0	2.84	772.4	4.29	20.70
118.....	H	110.5	7.37	128.0	6.09	442.2	2.42	666.6	2.55	16.46
119.....	H	149.2	9.95	168.0	8.00	459.7	2.47	679.9	3.53	18.73
120.....	H	96.3	6.42	73.4	4.45	557.7	3.05	572.7	3.13	19.64
121.....	H	135.5	9.03	158.0	7.55	518.1	3.20	665.8	3.66	21.90
169.....	H	131.5	10.10	158.5	6.71	498.6	2.85	684.4	3.76	20.00
170.....	H	150.5	10.00	164.0	6.71	521.1	2.73	629.0	3.26	18.73
171.....	H	150.5	10.30	145.5	6.94	509.6	2.86	618.3	3.40	19.30
172.....	H	134.5	10.30	143.5	6.94	509.6	2.86	618.3	3.40	18.43
173.....	H	132.0	10.13	153.0	7.29	483.8	2.66	582.4	3.20	18.43
174.....	H	165.0	11.00	163.0	7.76	534.1	2.93	658.9	3.62	20.42
Average.....	H	137.29	9.15	147.41	7.02	509.67	2.80	638.03	3.50	19.53
<b>Average of all Holsteins</b>										
		140.31	9.35	189.74	9.03	530.38	2.91	579.46	3.18	20.02

\*Received whole milk for 15 days.

\*\*Received re-made skim milk for 21 days.

Table 5. Feed Consumption and Feed Cost Per Unit of Growth

Calf No.	Breed	Feed consumption for one pound gain				Feed consumption for one inch gain			Feed cost for one lb. gain	Feed cost for one inch gain	
		Whole milk	Re-made skimmilk	Grain mixture	Alfalfa hay	Whole milk	Re-made skimmilk	Grain mixture			Alfalfa hay
Ration I											
1043.....	A	.51	.75	3.08	1.06	13.89	20.50	83.97	28.80	.09	\$2.54
1044.....	A	.50	1.18	2.21	2.28	9.07	21.26	39.80	41.07	.08	1.50
Average.....	A	.50	.96	2.64	1.67	11.48	20.88	61.87	34.95	.08	2.01
3016.....	G	.49	.91	1.98	2.20	11.66	21.46	46.91	52.17	.08	1.80
3017.....	G	.40	.74	2.16	2.47	8.08	24.53	43.92	50.01	.08	1.63
Average.....	G	.44	.82	2.07	2.34	9.85	22.91	45.41	51.10	.08	1.70
110.....	H	.30	.71	2.40	.93	7.09	16.53	55.98	21.74	.07	1.70
111.....	H	.56	1.55	2.56	.81	12.72	35.10	57.86	18.39	.08	1.90
112.....	H	.79	1.59	2.74	1.14	18.67	37.64	64.85	26.90	.09	2.23
113.....	H	.43	1.08	2.25	1.73	11.23	27.79	57.99	44.95	.08	2.03
114.....	H	.58	.78	1.94	2.55	14.40	19.46	48.54	63.58	.08	1.96
162.....	H	.53	.89	1.81	2.31	14.40	23.95	48.89	62.03	.07	2.01
163.....	H	.60	.89	1.91	2.78	13.99	20.85	44.88	65.33	.08	1.78
164.....	H	.48	.88	1.96	2.15	9.65	17.55	39.17	42.80	.08	1.50
166.....	H	.61	1.02	1.70	2.13	15.90	26.64	44.35	55.75	.07	1.85
167.....	H	.64	1.10	1.93	2.41	16.56	28.55	49.81	62.41	.08	2.06
168.....	H	.56	1.00	2.02	2.57	11.94	21.26	42.77	54.56	.08	1.73
Average.....	H	.55	1.04	2.11	1.95	13.31	25.04	50.47	47.12	.08	1.88
2077.....	J	.53	.85	2.08	2.20	10.57	16.79	41.20	43.66	.08	1.55
2078.....	J	.54	1.14	2.12	2.08	9.40	19.81	36.78	36.12	.08	1.40
Average.....	J	.54	.94	2.10	2.14	9.98	18.29	38.99	39.88	.08	1.49

Table 5. Feed Consumption and Feed Cost Per Unit of Growth (Continued)

Calf No.	Breed	Feed consumption for one pound gain				Feed consumption for one inch gain			Feed cost for one lb. gain	Feed cost for one inch gain
		Whole milk	Re-made skimmilk	Grain mixture	Alfalfa hay	Whole milk	Re-made skimmilk	Grain mixture		
Ration II										
3018.....	G	.53	.55	2.25	2.17	9.40	9.78	40.11	38.73	\$1.45
3019.....	G	.38	.26	2.22	2.47	8.53	8.43	50.34	55.85	1.73
Average.....	G	.46	.40	2.24	2.32	8.97	7.82	45.21	47.29	.08
116.....	H	.47	.66	2.27	3.24	10.92	15.42	52.58	75.10	2.06
117.....	H	.54	.59	2.31	3.49	12.47	13.51	53.09	80.14	.09
118.....	H	.41	.48	1.66	1.75	11.63	13.46	46.56	49.12	.06
119.....	H	.67	.76	1.99	3.04	17.98	20.24	53.09	80.85	.08
120.....	H	.35	.34	2.05	2.10	8.76	8.48	50.70	52.07	.07
121.....	H	.53	.68	2.27	2.60	12.22	15.60	52.43	59.99	.09
169.....	H	.58	.61	2.00	2.64	13.84	14.48	47.35	62.53	.08
170.....	H	.54	.54	1.90	2.27	13.41	12.57	44.25	52.91	.07
171.....	H	.54	.59	1.80	2.18	13.87	14.73	46.76	56.46	.07
172.....	H	.61	.57	2.00	2.42	14.81	13.94	48.84	59.26	.08
173.....	H	.68	.68	2.16	2.60	14.91	15.01	47.45	57.12	.08
174.....	H	.58	.57	1.87	2.30	13.87	13.72	44.91	55.42	.07
Average.....	H	.54	.59	2.02	2.55	13.23	14.27	49.00	61.75	.08
										1.88



**General Condition and Development of Experimental Animals:** Throughout the experiment the animals were unusually free from digestive disturbances. The only trouble experienced was when the calves were on the re-made skimmilk and this occurred in very few cases. The hair of the calves looked slightly rough when the re-made skimmilk was discontinued at six weeks of age. At six months of age all of the calves were in good condition, the hair was glossy and the hide pliable. At no time during the experiment did the calves have an unthrifty appearance. The general condition and development of the calves was very satisfactory, being in no way inferior to that of calves raised on separated skimmilk under favorable conditions.

Figures 5 to 10 inclusive illustrate the condition and development that was characteristic of all of the animals included in the experiment.

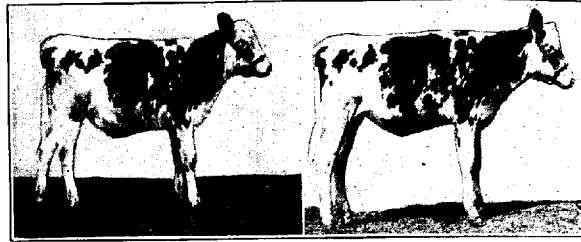


Figure 5. Holstein No. 169, at three months of age and at six months of age.



Figure 6. Holstein No. 173 at three and one-half months of age and at six months of age.



Figure 7. Holstein No. 114 at three months of age.

Figure 8. Jersey No. 2078 at six months of age.



Figure 9. Ayrshire No. 1044 at four months of age.

Figure 10. Guernsey No. 3017 at five months of age.

### Summary

(1) Thirty-one dairy heifers were raised on a dry calf meal containing 25 per cent of powdered skim milk.

(2) These heifers were normal in size at six months of age.

(3) The average feed consumption of 23 Holstein heifers from birth to six months was: whole milk 140.3 pounds, re-made skim milk 189.7 pounds, grain mixture 530.4 pounds, alfalfa hay 579.5 pounds.

(4) The average feed cost for the Holstein heifers was \$20.02 to six months of age.

(5) The average daily gain in weight was 1.42 pounds which is normal for Holstein heifers.

(6) The average feed cost per pound of gain was 7.76 cents.

(7) Grain mixture No. I which contained 10 per cent of blood meal gave slightly better growth than mixture No. II which contained 5 per cent.

(8) The calves raised by this system were thrifty and vigorous at six months of age and in no way distinguishable from heifers raised in the usual way on separated skim milk.

### Conclusions

The system of raising dairy heifers as used in this experiment can be successfully used by dairymen where liquid skim milk is not available.

In areas where whole milk is sold, this system materially reduces the cost of raising calves.

Feeding the dried skim milk in the grain mixture reduces the labor required for feeding calves.

The use of large quantities of dried skim milk in feeding dairy calves should have a healthy influence on the dairy industry by providing an additional outlet for this by-product.

### Recommended Feeding Schedule for Raising Dairy Calves on W. S. C. Dry-Fed Calf Mixture Containing Dry Skim Milk

1. Feed mother's milk to calf for 48 hours.
2. Feed whole milk until two weeks of age.
3. At one week of age, place grain mix in front of the calf and encourage it to eat it.
4. Keep good quality alfalfa hay and clean water before the calf at all times.
5. At two weeks of age, gradually change to the powdered skim milk

solution, using one pound of dried skimmilk to nine pounds of water. About a week is required to make the change.

6. At five weeks, gradually discontinue the powdered skimmilk solution.

7. At four weeks of age, the calves should be eating considerable alfalfa hay and from one to two pounds per day of the grain mixture.

#### Grain Mixture

	Pounds
Powdered skimmilk .....	250
Ground barley .....	200
Ground oats .....	200
Wheat bran .....	150
Blood meal .....	100
Linseed meal (old process) .....	70
Sterilized bone flour .....	20
Salt .....	10

The calves are fed whole milk and skimmilk solution at the rate of one pound per ten pounds live weight.

The calves are placed on the regular herd feed mixture at six months of age.

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